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Performance Prediction of the Planck Sorption Cooler and Initial Validation *

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Two continuous operation 18 K/20 K sorption coolers are being developed by JPL for the ESA Planck mission to provide about 200 mW of cooling at 18 K and 1.4 W at 20 K. A detailed performance prediction model has been developed to support the design process and to evaluate the results of a prototype testing. The performance of these coolers depends on many synergistically related operating parameters (such as the temperatures of precooling thermal shield and the warm radiator) and they can only be assessed through a detailed modeling of each component coupling. This model predicts the time varying temperature, pressure and H_2 concentration gradients within the metal hydride beds, the H_2 flow rate, cooling power produced in the coldhead, and the oscillations of the coldhead temperature. The model incorporates the detailed geometry of each compressor element, the hydride sorption/desorption non-linear characteristics and it has been validated at the component level. Each component model has been parametrically described to allow trade off evaluation and the possibility to use it for different environmental and cooling requirements and for other sorption coolers. The full validation of the model will be obtained by comparison of the performance predictions to the experimental data for the engineering prototype being built at JPL. The laboratory tests that will be performed to validate the whole cooler system have also been described.

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